NASA Advisory Council
National Aeronautics and Space Administration
Washington, DC 20546

General Lester L. Lyles (USAF, Ret.), Chair

June 6, 2019

Mr. James F. Bridenstine
Administrator
National Aeronautics and Space Administration
Washington, DC 20546

Dear Administrator Bridenstine: Jim

The NASA Advisory Council held its first public meeting of 2019 at NASA Headquarters, Washington, DC, on May 30-31, 2019.

As a result of our deliberations, and in accordance with our "two-tier" approach for transmitting recommendations and findings to the NASA leadership, the Council approved two Council recommendations and three Council findings for your consideration (enclosed). The Council also approved three Committee recommendations and eight Committee findings for consideration by the NASA Associate Administrators. Copies of the latter also are enclosed for your information and awareness. If you have any questions or wish to discuss this further, please do not hesitate to contact me.

With regard to the new Artemis program to land humans on the Moon by 2024, the Council agrees that the analysis and tradeoffs examined thus far to define the new architecture appear to provide a sound underpinning for the current plans to go forward on the accelerated schedule. With regard to NASA's role in STEM education, the Council remains concerned about the proposed FY 2020 budget cut that would eliminate NASA's Office of STEM Engagement, especially in light of NASA's unique role in inspiring the next generation to pursue careers in STEM-related fields. The Council looks forward to learning more about NASA's plans and actions to continue supporting STEM engagement if the Office of STEM Engagement is closed.

I look forward to discussing these recommendations and findings with you in the future.

Sincerely, v/r

General Lester L. Lyles (USAF, Ret.)
Chair

Enclosures

NASA Advisory Council Recommendation

Lunar Plans
2019-01-01 (HEOC-01)

Name of Committee:	Human Exploration and Operations Committee
Chair of Committee:	Mr. Wayne Hale
Date of Council Public Deliberation:	May 31, 2019
Short Title of Recommendation:	Lunar Plans

Recommendation:
The NASA Advisory Council recommends that the current planning for human spaceflight to the Moon continue along the lines of the recent planning study to include long-term sustainability features including reusability, refueling, and in situ resource utilization at a "gateway" or reusable aggregation point.

Major Reasons for the Recommendation:
NASA has been doing trade studies on how to return to the Moon for decades and the recent acceleration study included the results from all previous trade studies. To ensure the long-term viability of human spaceflight, efficient and affordable measures must be taken to reduce costs and enhance flexibility. Having a rally point or aggregation mode with human shelter capability appears to be the best way to minimize long-term costs and provide flexibility. The Council concludes that a dash to the Moon without including infrastructure for the longer term would not lead to a sustainable program of deep space human exploration. Near-term focus on rapid lunar missions should not distract from the long-term objectives.

Consequences of No Action on the Recommendation:
A higher cost program with limited scope and decreased long-term viability would most likely result from a different approach. The intent of Space Policy Directive-1 (SPD-1) would not be met.

NASA Advisory Council Recommendation

Science, Technology, Engineering and Mathematics (STEM)
2019-01-02 (SEC/HEOC-01)

Name of Committee:	STEM Engagement Committee Human Exploration and Operations Committee
Chair of Committee:	Dr. Aimee Kennedy Mr. Wayne Hale
Date of Council Public Deliberation:	May 30-31, 2019
Short Title of Recommendation:	STEM

Recommendation:
The NASA Advisory Council recommends that NASA continue to inspire the next generation and encourage them to pursue STEM careers through direct interaction with students, particularly in underserved communities. NASA is uniquely positioned to inspire the next generation. The Council notes the need for a budget commensurate to meet this requirement. In addition, the Council commends the Office of STEM Engagement (OSTEM) and its continuous improvement approach to its work. It is making good progress on the work plans previously presented (i.e., Business Services Assessment findings, NASA STEM Engagement strategy, Federal Five-Year STEM Plan).

Major Reasons for the Recommendation:
As NASA pursues Artemis, a long-term sustainable program to return American astronauts on American rockets to the Moon by 2024, now is the time to inspire and build this next generation workforce. The budget required to accomplish this needs to be provided to achieve these goals. This would be helpful to the economic improvement of disadvantaged locations. With regard to OSTEM, it continues to align their STEM engagement programs for maximum impact, and continues to leverage scalability of their reach through strategic partnerships.

Consequences of No Action on the Recommendation:
Lack of workforce in the future and lack of public support for current programs.

NASA Advisory Council Finding

Streamlining Commercial Spaceflight Requirements and Regulations

Name of Committee:	Human Exploration and Operations Committee
Chair of Committee:	Mr. Wayne Hale
Date of Council Public Deliberation:	May 31, 2019
Short Title of Finding:	Streamlining Commercial Spaceflight Requirements and Regulations

Finding: NASA's Commercial Crew Program office and the Space Communications and Navigation office have done excellent work to help commercial programs cut through interagency bureaucracy. These organizations are commended for this work. The commercialization of activities in low Earth orbit is a goal of the U.S. Government, yet the multiple interagency bureaucracy surrounding space activities is very difficult to navigate. NASA should continue to help commercial space efforts by providing guidance and advocacy in the streamlining of the complex bureaucracy surrounding space activities. NASA should continue to provide leadership to coordinate responsibilities across the U.S. Government.

NASA Advisory Council Finding

Intellectual Property Reform

Name of Committee:	Regulatory and Policy Committee
Chair of Committee:	Mr. Michael Gold
Date of Council Public Deliberation:	**May 31, 2019**
Short Title of Finding:	Intellectual Property Reform

Finding: The Council fully endorses NASA's efforts to obtain legislative relief to ensure that the Agency can, at its discretion, waive Intellectual Property rights related to commercial research and development on the International Space Station and future destinations for the U.S. Government as a whole.

NASA Advisory Council Finding

Orbital Debris Mitigation

Name of Committee:	Regulatory and Policy Committee
Chair of Committee:	Mr. Michael Gold
Date of Council Public Deliberation:	May 31, 2019
Short Title of Finding:	Orbital Debris Mitigation

Finding: The Council fully endorses NASA's efforts within the U.S. Government to advocate for a unified, government-wide, performance-based approach to orbital debris mitigation that avoids regulatory redundancy and conflict, and integrates expertise from all relevant agencies. Additionally, the Council commends NASA Administrator Jim Bridenstine for his leadership in raising concerns regarding the Indian anti-satellite test and the need to preserve the safety of the orbital environment.

NASA Advisory Council – Committee Recommendation

Human Exploration and Operations Committee Recommendation to NASA Associate Administrator for Human Exploration and Operations Mission Directorate

Streamline NASA Decision Making

Name of Committee:	Human Exploration and Operations Committee
Chair of Committee:	Mr. Wayne Hale
Date of Council Public Deliberation:	May 31, 2019
Short Title of Recommendation:	Streamline NASA Decision Making

Recommendation:
To achieve the goal of human landing on the Moon by 2024, NASA decision making must be more rapid while still making appropriate decisions. It is recommended that the governance models be reviewed and revised, and new organizations (such as the lunar lander program) be organized in such a way to ensure rapid, accurate decision making. Decisions should be made at the lowest acceptable level, and multiple reviews and "analysis paralysis" must be avoided.

Major Reasons for the Recommendation:
Currently, NASA decision making culture has grown in an environment of slow activities and multiple reviews at a very high level. To ensure the success of large scale and fast paced programs which will be required by the lunar initiative, a return to the type of decision making that was the hallmark of the Agency in the 1960's is required. This means that multiple high level reviews should be reduced to the minimum possible, and decision making should be delegated to the lowest level of authority practical. While safety concerns are always a top consideration, the necessity to make rapid and appropriate decisions will be critical, and measures must be taken to change the organizational culture as well as the documented processes to accommodate the new time scale.

Consequences of No Action on the Recommendation: Current programmatic decision making processes and culture in NASA are not appropriate to the new accelerated lunar program. Without significant change in decision making processes, the new programs will not accomplish the goals required and certainly not within the time frame which has been established.

NASA Advisory Council – Committee Recommendation

Regulatory and Policy Committee Recommendation
to NASA Associate Administrator for
Human Exploration and Operations Mission Directorate

Due Priority for Access to Private Sector Hardware

Name of Committee:	Regulatory and Policy Committee
Chair of Committee:	Mr. Michael Gold
Date of Council Public Deliberation:	May 31, 2019
Short Title of Recommendation:	Due Priority for Access to Private Sector Hardware

Recommendation:
When determining how limited resources for supporting commercial activities on the International Space Station (ISS) should be utilized, projects that required substantial private sector investment in hardware aboard the ISS should be given due priority during the consideration process.

Major Reasons for the Recommendation:
Successfully commercializing Low Earth Orbit (LEO) plays a vital role in achieving NASA's mission of returning astronauts to the Moon by 2024. Transitioning LEO to the private sector will allow NASA to focus its resources on deep space exploration to the Moon, Mars and beyond. Substantial private sector investment will be required to generate sufficient revenue to support the nontrivial costs of crewed LEO operations. Ensuring that companies which invest in private sector hardware that is flown aboard the ISS are given due consideration for gaining access to the systems they paid for is both equitable and necessary to encourage such investments.

Consequences of No Action on the Recommendation: LEO commercialization efforts will be substantially hampered and companies will be discouraged from investing their own funds in hardware to conduct private sector research and development, manufacturing, etc., aboard the ISS.

NASA Advisory Council – Committee Recommendation

Science Committee Recommendation to NASA Associate Administrator for Science Mission Directorate

Multi-Tiered Strategy to Facilitate Diverse Teams and Safe Environments

Name of Committee:	Science Committee
Chair of Committee:	Dr. Meenakshi Wadhwa
Date of Council Public Deliberation:	May 30, 2019
Short Title of Recommendation:	Multi-Tiered Strategy to Facilitate Diverse Teams and Safe Environments

Recommendation:
The Science Committee recommends that the NASA Science Mission Directorate (SMD) develop a multi-tiered strategy to facilitate diverse teams and safe environments. To achieve these goals, the Science Committee recommends the following actions:

- The Committee strongly encourages the development of a five-year strategic plan for Diversity, Equity and Inclusion (DEI), as a first step in the process.
- The Committee strongly endorses the continuation of the "Principal Investigator 101" and "Principal Investigator Incubator" programs recently developed by SMD.
- SMD should continue its DEI-enlightened proposal review processes, including diverse review panels, providing DEI training at the beginning of every proposal review, the clear explanation of evaluation criteria, and the enforcement of these policies and criteria throughout the panels.
- SMD Announcements of Opportunity should include a required element of how the proposed activities and proposal team aligns with NASA's DEI goals.

Major Reasons for the Recommendation:
Efforts are needed to improve diversity of the SMD workforce and grant/contract awardee cohort, as well as inclusivity and equity (to make all feel welcome and to address systemic disparities). These are needed to patch the "leaky" pipeline affecting recruitment and retention, ensure a culture that values inclusion/equity, and assure that the next generation of STEM professionals inspired by NASA is truly reflective of the entire nation. In addition, it is important for potential Principal Investigators to be trained and be ready to serve in such roles. NASA is already making strides in this direction with the "Principal Investigator 101" and "Principal Investigator Incubator" programs.

Consequences of No Action on the Recommendation:
Diverse teams working in equitable and inclusive environments have been shown to produce more creative solutions. Inaction would leave the NASA workforce and grant/contract awardee cohort dominated by a single demographic not reflective of the nation's demographics.

NASA Advisory Council – Committee Finding

Technology, Innovation and Engineering Committee Finding to NASA Associate Administrator for Space Technology Mission Directorate

Satellite Servicing

Name of Committee:	Technology, Innovation and Engineering Committee
Chair of Committee:	Mr. James Free
Date of Council Public Deliberation:	May 30, 2019
Short Title of Finding:	Satellite Servicing

Finding: The NAC Technology, Innovation and Engineering Committee was impressed by continued progress of satellite servicing with respect to commercialization. For example, the industry events seem to be generating excellent awareness and dialogue. The Committee would like to encourage continued focus on the technology infusion to commercial industry as a focus for NASA.

NASA Advisory Council – Committee Finding

Technology, Innovation and Engineering Committee Finding to NASA Chief Technologist

Digital Transformation

Name of Committee:	Technology, Innovation and Engineering Committee
Chair of Committee:	Mr. James Free
Date of Council Public Deliberation:	May 30, 2019
Short Title of Finding:	Digital Transformation

Finding: The NAC Technology, Innovation and Engineering Committee was impressed by the NASA Office of the Chief Technologist (OCT) efforts thus far in formulating and implementing a plan for a Digital Transformation Initiative: a strategy for NASA to employ digital technologies to transform its processes, products and capabilities yielding substantial performance improvements. The Committee believes that OCT's current work is notable, but could also benefit from incorporating input from academic institutions and laboratories, which could be leveraged to enhance the Agency's progress and ultimately, its implementation plan.

NASA Advisory Council – Committee Finding

Technology, Innovation and Engineering Committee Finding to Associate Administrator for Space Technology Mission Directorate

Nuclear Thermal Propulsion

Name of Committee:	Technology, Innovation and Engineering Committee
Chair of Committee:	Mr. James Free
Date of Council Public Deliberation:	May 30, 2019
Short Title of Finding:	Nuclear Thermal Propulsion

Finding: The NAC Technology, Innovation and Engineering Committee believes that a Nuclear Thermal Propulsion (NTP) system could reduce crew transit time to Mars and increase mission flexibility which would enable a human exploration campaign. The Committee finds that much progress has been made by STMD's NTP project which is addressing the key technology challenges related to determining the feasibility and affordability of a Low Enriched Uranium (LEU)-based NTP engine. For example:

- The project is maturing technologies associated with fuel production, fuel element manufacturing and testing
- The project is developing reactor and engine conceptual designs
- The project is performing a detailed cost analysis for developing an NTP flight system

The Committee notes that there is considerable stakeholder interest in doing a near-term NTP flight demonstration mission. STMD is responding by initiating a "mission concept-like study" which will bring together industry and other government agencies to evaluate concepts to execute a flight demonstration mission in the near-term timeframe. Once current STMD NTP assessments and studies are completed, the Committee encourages Agency leadership to provide clear direction on the future course of NTP development.

NASA Advisory Council – Committee Finding

Aeronautics Committee Finding
to NASA Associate Administrator for
Aeronautics Research Mission Directorate

Airspace Vision Beyond NextGen

Name of Committee:	Aeronautics Committee
Chair of Committee:	Mr. John Borghese
Date of Council Public Deliberation:	May 30, 2019
Short Title of Finding:	Airspace Vision Beyond NextGen

Finding: The Aeronautics Committee finds that NASA lacks a well-understood return on investment on the Airspace Technology Demonstration (ATD) project that defines the future benefit for the nation. If the Airspace Operations and Safety Program is not successful, we may not have a competitive urban air mobility (UAM) industry. The advancements in the air traffic control system are necessary for achieving a safe and reliable national air transportation capability. The Committee encourages NASA to continue demonstrating the technologies long-term to obtain more data on the impacts of the UAM integration into the airspace. The Committee noted the reduction of the NASA ARMD budget starting in 2023 and suggested that the success by NASA in these new markets for autonomous vehicles and supersonic flight could justify a higher budget.

NASA Advisory Council – Committee Finding

Aeronautics Committee Finding
to NASA Associate Administrator for
Aeronautics Research Mission Directorate

University Leadership Initiative Progress

Name of Committee:	Aeronautics Committee
Chair of Committee:	Mr. John Borghese
Date of Council Public Deliberation:	May 30, 2019
Short Title of Finding:	University Leadership Initiative Progress

Finding: The Aeronautics Committee applauds NASA on its flexibility on trying to find the optimal mechanism on the University Leadership Initiative. The Committee emphasized the need to assure diversity when selecting proposals from the universities and to track and show statistics. The Department of Defense agencies require Historically Black Colleges and Universities (HBCU) participation in certain research solicitations to ensure diversity. The Aeronautics Research Mission Directorate may want to consider an approach along these lines. The Committee also found that there is a need to drive the message that aeronautics is not only relevant, but serves as a pioneering application for 21st century technology innovation. NASA needs to be more proactive when engaging with and advertising these opportunities to the university community.

NASA Advisory Council – Committee Finding

Science Committee Finding
to NASA Associate Administrator for
Science Mission Directorate

Draft Science Strategy of the Moon

Name of Committee:	Science Committee
Chair of Committee:	Dr. Meenakshi Wadhwa
Date of Council Public Deliberation:	May 30, 2019
Short Title of Finding:	Draft Science Strategy of the Moon

Finding: The Science Committee finds the following regarding the draft Science Strategy of the Moon:

(a) Why Return to the Moon - The Committee finds that the draft Strategy's introduction lacks a well-articulated narrative regarding the opportunity presented by returning to the Moon at this time, which could invite the perception that it is simply an "it's about time" endeavor. A narrative, perhaps around the scientific and technological advancements that have occurred over these past 50 years, could highlight NASA's progress and articulate why now is a rich environment in which to return to the Moon to further our exploration capabilities and scientific understanding.

(b) Science Goals - Three of the four Science Goals in the draft Strategy are derived from multiple community-based documents and are well-articulated and well-justified. However, one of the goals (Science Goal #3; particularly subgoals 3A and 3C) is based primarily on outcomes from a single workshop (Deep Space Gateway Concept Science Workshop, held on February 27 - March 1, 2018). The science areas in this goal were not as well-justified or as clearly stated as for the other goals. For instance, it was not clear what was meant by "identical sensors", and what the level of "high temporal frequency" would be. It was also not clear what was "novel and unique" about the science in the areas of heliophysics, astrophysics, and Earth science enabled by going to the Moon.

(c) Partial Gravity - In the NASA Science Role section of the draft Strategy, there is no mention of the fact that lunar exploration will also provide the first opportunity for scientific study of the effect of partial gravity on human health and performance. Such research is expected to fall under the purview of NASA's Human Exploration and Operations Mission Directorate (at Johnson Space Center's Human Health and Performance Directorate) and is not referenced in this document. Mention of this research in this document would be informative to readers of this important NASA scientific activity.

(d) Priorities and Principles - In the Priorities and Principles section of the draft Strategy, the third bullet is redundant with the second bullet. Also, for the fourth bullet, it is unclear what is meant by "providing situational awareness." If referring to space weather, this could be clarified.

Priorities and Principles (DRAFT)

- Achieve the decadal survey objectives across the disciplines that can be addressed at the Moon or near the Moon
- Perform all research to the standards of NASA Science, including competitive selections, open data policies, etc.
- Enable competitive research through Mission of Opportunities or otherwise on or around the Moon
- Actively enable human exploration through providing situational awareness

NASA Advisory Council – Committee Finding

Science Committee Finding
to NASA Associate Administrator for
Science Mission Directorate

Draft NASA Science Plan

Name of Committee:	Science Committee
Chair of Committee:	Dr. Meenakshi Wadhwa
Date of Council Public Deliberation:	May 30, 2019
Short Title of Finding:	Draft NASA Science Plan

Finding: The Science Committee finds the following regarding the draft NASA Science Plan:

(a) Introduction and Future State – The Science Mission Directorate (SMD) is in an exciting era when there is transformational potential for a science strategy that enables excellence and innovation. We see inspirational language that speaks to this in each of the Focus Areas, and in the "2024 Future State" summary of the Science Update presentation, but find the introduction section to be merely descriptive by comparison. An introduction and conclusion that capture the visionary and ambitious plan for the future would provide much needed context for the document. It may also be useful to identify the SMD divisions in the introduction below the description of the key science themes.

(b) Rename "Protect and Improve" Theme – One of the three themes, "Protect and Improve Life on Earth" (highlighted in the Introduction and the SMD Mission Statement) does not inspire the same level of wonder and excitement as the other two themes; as written, it implies an applied science focus rather than the discovery science implied by the other two themes. This theme could be re-worded along the lines of the following:

- "Unlocking the mysteries of our planet"
- "Advancing the frontiers for humanity"

The first of these options conveys the excitement for exploring the many unknowns of our interconnected planet (Earth system). The second of these options conveys the message that NASA SMD pushes the forefront of knowledge for applications that benefit life and society.

(c) Interconnectivity and Partnerships – While there is discussion of collaboration with the Human Exploration and Operations Mission Directorate (HEOMD) and the Space Technology Mission Directorate (STMD) specifically in the context of the exploration initiative (in Strategy 1.2), the document does not sufficiently or broadly highlight the areas and mechanisms for interconnectivity and partnerships between SMD and the other Mission Directorates.

(d) Foster Innovation – The SC finds the use of the word "create" in Strategies 2.1 and 2.2 of the draft NASA Science Plan to neglect the work that is currently being done to seed a culture that embraces innovation and collaboration. Use of words such as "foster" or "grow" would communicate the need for progress, while acknowledging that work has already begun in these areas.

> **STRATEGY 2.1:** Create a culture that encourages innovation and entrepreneurship across all elements of the NASA Science portfolio.
> **STRATEGY 2.2:** Create a culture that encourages collaboration in pursuit of common goals.

(e) Diversity, Equity and Inclusion – While referencing the importance of diversity (e.g., in the Teamwork section and in Strategy 4.1), it was noted that there is not adequate emphasis on equity and inclusion in the document. Diversity alone is not sufficient to ensure the best outcomes in driving excellence and innovation.

(f) Human Health in Space – This draft NASA Science Plan document covers the activities of SMD. The Space Life and Physical Sciences Research and Applications (SLPSRA) Division, part of HEOMD, supports research on the effects of spaceflight on human health and performance and on biological and physical systems. These scientific activities are discussed in SLPSRA's strategic plan and could be referenced here to increase readers' awareness of the full scope of science at NASA.

(g) Portfolio Summaries – The draft NASA Science Plan portfolio summaries for the programs within each division should include all programs listed for each division in SMD's Science Budget Request Summary table. In the planetary science portfolio summary, the Outer Planets and Ocean Worlds Program was omitted.

NASA Advisory Council – Committee Finding

Science Committee Finding
to NASA Associate Administrator for
Science Mission Directorate

Science and Technology Definition Teams

Name of Committee:	Science Committee
Chair of Committee:	Dr. Meenakshi Wadhwa
Date of Council Public Deliberation:	May 30, 2019
Short Title of Finding:	Science and Technology Definition Teams

Finding: The Science Committee is concerned about the switch to Federal Advisory Committee Act (FACA) authorization for Science and Technology Definition Teams (STDTs) for upcoming mission concept development. This means that STDTs cannot recommend any implementation strategies, but instead only make recommendations on the science investigations and measurement requirements necessary to address these objectives. This has several negative ramifications. One impact is that this slows the process of NASA science mission development. The Science Mission Directorate must now conduct an implementation analysis after the STDT, rather than doing this as part of the STDT process. Another impact is the potential for cost growth. The development of science objectives and measurement requirements independently from technical implementation concepts and associated cost analysis could lead to financially unfeasible missions. When these steps are integrated, cost targets can be included in the science objective formulation discussion.